REMARKS

This application is based on international application no. PCT/IB99/01724 that was filed and published with claims 1-85. The claims in the international application were amended 21 November 2000 by canceling originally-filed claims 1-40 and by renumbering originally-filed claims 41 to 85 as claims 1-45. Amended sheets for the claims were issued with the International Preliminary Examination Report (IPER). It is requested that the claims in this U.S. application be amended per the claims in the IPER.

Attached hereto is a clean version of the claims. This version contains originally-filed claims 41 to 85 that have been renumbered as claims 1-45. A marked-up version indicating the changes is attached.

The Office Action indicated the application did not contain an Abstract. An Abstract on a separate sheet is being provided.

Please charge any fees, or credit any overpayments, to deposit account no. 50-1720 (14.0125-PCT-US). A duplicate copy of this letter is attached.

Respectfully submitted,

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MARKED-UP VERSION OF CLAIMS

CLAIMS

1. A method of acquiring seismic data adapted for a land or transition zone environment, said method comprising the steps of:
placing a location identifier in a particular location;
placing a seismic sensor near said location identifier;
reading said location identifier using a seismic data cable;
recording seismic data acquired by said seismic sensor using said cable;
and assigning sensor position coordinates to said seismic data based on measured position coordinates of said location identifier.

2. A method as claimed in claim 1, further including the step of developing a planned seismic sensor lay-out scheme containing planned seismic station locations, said location identifier being placed near one of said planned seismic locations.

3. A method as claimed in claim 2, in which said seismic data acquired by said seismic sensor is recorded and said location identifier is read using a common cable take-out on said seismic data cable.

4. A method as claimed in claim 3, in which said seismic sensor is one of a plurality of seismic sensors placed near said location identifier.

5. A method as claimed in claim 4, in which said plurality of seismic sensors form a single geophone string.

6. A method as claimed in claim 5, in which said location identifier is read using electrical, optical, or magnetic means.

7. A method as claimed in claim 6, in which said location identifier is remotely readable using a device attached to said seismic data cable near said location identifier.

8. A method as claimed in claim 7, in which said seismic data cable has a plurality of acquisition channels and said location identifier is used to determine whether a particular said acquisition channel has been skipped during seismic sensor deployment.

9. A method as claimed in claim 8, in which said seismic data cable has a plurality of acquisition channels and said location identifier is used to determine whether a particular said acquisition channel has been skipped during seismic sensor deployment.

10. A method as claimed in claim 9, in which said location identifier has a tag value.

11. A method as claimed in claim 10, further comprising the step of creating a look-up table matching measured location identifier position coordinates with tag values.

12. A method as claimed in claim 11, in which said identifier comprises resistors and/or capacitors and said tag values comprise resistance and/or capacitance values.

13. A method as claimed in claim 12, in which said resistance and/or capacitance values are read using conventional geophone impedance testing equipment.

14. A method as claimed in claim 9, in which said location identifier position coordinates are stored within a memory incorporated within said location identifier.

15. A method as claimed in claim 14, in which said location identifier position coordinates are measured using land-based surveying equipment.

16. A method as claimed in claim 14, in which said location identifier position coordinates are measured using satellite-based global positioning system equipment.

17. A method as claimed in claim 14, in which said location identifier position coordinates are stored within said memory by a satellite-based global positioning system unit attached to said location identifier.

18. A method as claimed in claim 17, in which said sensor position coordinates are calculated using a measured distance between said location identifier and said seismic sensor.

19. A method as claimed in claim 18, in which said distance between said location identifier and said seismic sensor is measured using acoustic transmission and reception equipment that utilize an airborne acoustic signal.

20. A method as claimed in claim 19, in which said sensor position coordinates are calculated using an acoustic triangulation scheme.

21. An apparatus adapted for seismic data acquisition in a land or transition zone environment, said apparatus comprising:
a location identifier;
a seismic sensor capable of being placed near said location identifier;
a seismic data cable;
means for reading said location identifier using said seismic sensor using said seismic data cable; and
means for assigning sensor position coordinates to said seismic data based on measured position coordinates of said location identifier.

22. An apparatus as claimed in claim 21, in which said means for recording seismic data acquired by said seismic sensor and said means for reading said location identifier use a common cable take-out on said seismic data cable.

23. An apparatus as claimed in claim 22, in which said seismic sensor is one of a plurality of seismic sensors capable of being placed near said location identifier.

24. An apparatus as claimed in claim 23, in which said plurality of seismic sensors form a single geophone string.

25. An apparatus as claimed in claim 24, in which said means for reading said location identifier uses electrical, optical, or magnetic means.

26. An apparatus as claimed in claim 25, in which said means for reading said location identifier includes a device attached to said seismic data

cable near said location identifier that remotely reads said location identifier.

27. An apparatus as claimed in claim 26, in which said seismic data cable has a plurality of acquisition channels and said means for reading said location identifier is used to determine whether a particular said acquisition channel has been skipped during seismic sensor deployment.

28. An apparatus as claimed in claim 27, in which said location identifier has a tag value.

29. An apparatus as claimed in claim 28 further including a look-up table that matches measured location identifier position coordinates with tag values.

30. An apparatus as claimed in claim 29, in which said location identifier comprises resistors and/or capacitors and said tag values comprise resistance and/or capacitance values.

31. An apparatus as claimed in claim 30, in which said means for reading said location identifier comprises conventional geophone impedance testing equipment capable of reading said resistance and/or capacitance values.

32. An apparatus as claimed in claim 27, in which said location identifier further includes an integral memory.

33. An apparatus as claimed in claim 32, in which said location identifier position coordinates are measured using land-based surveying equipment.

34. An apparatus as claimed in claim 32, in which said location identifier position coordinates are measured using satellite-based global positioning system equipment.

35. An apparatus as claimed in claim 32, in which said location identifier further includes an attached satellite-based global positioning system unit that stores said location identifier position coordinates within said memory.

36. An apparatus as claimed in claim 35, further including means for measuring the distance between said location identifier and said seismic sensor.

37. An apparatus as claimed in claim 36, in which said means for measuring the distance between said location identifier and said seismic sensor comprises acoustic transmission and reception equipment that utilize an airborne acoustic signal.

38. An apparatus as claimed in claim 37, in which said means for measuring the distance between said location identifier and said seismic sensor uses an acoustic triangulation scheme.

39. An apparatus as claimed in claim 38, in which said means for measuring the distance between said location identifier and said seismic sensor includes an acoustic receiver connected to said seismic sensor.

40. An apparatus as claimed in claim 39, in which said means for measuring the distance between said location identifier and said seismic sensor includes a pair of acoustic transmitters, at least one of which is attached to an acoustic receiver.

41. 1 An apparatus adapted for seismic data acquisition in a land or transition zone environment, said apparatus comprising:
a positioning device;
a seismic sensor, capable of being placed near said positioning device;
and means for determining the distance between said seismic sensor and said positioning device using an airborne acoustic transmission between said positioning device and said seismic sensor.

42. 2 An apparatus as claimed in claim 41, in which said airborne acoustic transmission is produced by a speaker at said positioning device and received by a microphone at said seismic sensor.

43. 3 An apparatus as claimed in claim 42, in which said airborne acoustic transmission received by said microphone at said seismic sensor is converted from analog to digital format using an analog to digital converter that is also used to convert seismic signals received by said seismic sensor from analog to digital format.

~~44.~~ 4 An apparatus as claimed in claim 43, in which said airborne acoustic transmission received by said microphone at said seismic sensor is transmitted using a cable that is also used to transmit seismic data received by said seismic sensor.

~~45.~~ 5 An apparatus as claimed in claim 44, in which said airborne acoustic transmission is a spread spectrum acoustic signal.

~~46.~~ 6 An apparatus as claimed in claim 45, in which said airborne acoustic transmission is a pulse, frequency sweep, or digitally encoded sweep acoustic signal.

~~47.~~ 7 An apparatus as claimed in claim 44, in which said airborne acoustic transmission is generated by signal generation circuitry that is also used to test said seismic sensor.

~~48.~~ 8 An apparatus as claimed in claim 47, further including a temperature sensor for measuring the temperature of the air near said seismic sensor or said positioning device.

~~49.~~ 9 An apparatus as claimed in claim 48, further including a survey flag and wherein said positioning device is placed near said survey flag.

~~50.~~ 10 An apparatus as claimed in claim 49, in which said positioning device is a first positioning device and further including a second positioning device and means for determining the distance between said second positioning device and said seismic sensor using an airborne acoustic

transmission between said second positioning device and said seismic sensor.

~~51.~~ 11. An apparatus as claimed in claim 50, further including means for determining the distance between said first positioning device and said second positioning device.

~~52.~~ 12. An apparatus as claimed in claim 51, in which said means for determining the distance between said first positioning device and said second positioning device uses an airborne acoustic transmission between said first positioning device and said second positioning device.

~~53.~~ 13. An apparatus as claimed in claim 52, in which said first positioning device and said second positioning device are connected by a cable.

~~54.~~ 14. An apparatus as claimed in claim 53, in which said second positioning device is placed at a predetermined azimuthal orientation with respect to said first positioning device.

~~55.~~ 15. An apparatus as claimed in claim 54, further including means for confirming that said second positioning device has been placed at a predetermined azimuthal orientation with respect to said first positioning device.

~~56.~~ 16. An apparatus as claimed in claim 55, in which a seismic source signal is used to determine to resolve the line symmetry ambiguity when determining the position of said seismic sensor with respect to said first positioning device and said second positioning device.

~~57~~. 17 An apparatus as claimed in claim 56, wherein said seismic sensor is a first seismic sensor and further including additional seismic sensors and means for determining the distance between said additional seismic sensors and said positioning device using airborne acoustic transmission between said positioning device and said additional seismic sensors.

~~58~~. 18 An apparatus as claimed in claim 57, further including means for calculating a group center of gravity for said first seismic sensor and said additional seismic sensors.

~~59~~. 19 An apparatus as claimed in claim 57, further including means for determining whether said first seismic sensor and said additional seismic sensors have been laid out in a prescribed order.

~~60~~. 20 An apparatus as claimed in claim 59, in which said seismic sensor and said positioning device are located at a first seismic station and further including an additional positioning device located at a second seismic station and means for determining the distance between a device located at said first seismic station and a device located at said second seismic station.

~~61~~. 21 A method of determining the position of a seismic sensor adapted for seismic data acquisition in a land or transition zone environment, said method comprising the steps of:

placing a positioning device in a particular location;

placing a seismic sensor near said positioning device; and

determining the distance between said seismic sensor and said positioning device using an airborne acoustic transmission between said positioning device and said seismic sensor.

~~62~~. 32 A method as claimed in claim 61, in which said airborne acoustic transmission is produced by a speaker at said positioning device and received by a microphone at said seismic sensor.

~~63~~. 33 A method as claimed in claim 62, in which said airborne acoustic transmission received by said microphone at said seismic sensor is converted from analog to digital format using an analog to digital converter that is also used to convert seismic signals received by said seismic sensor from analog to digital format.

~~64~~. 34 A method as claimed in claim 63, in which said airborne acoustic transmission received by said microphone at said seismic sensor is transmitted using a cable that is also used to transmit seismic data received by said seismic sensor.

~~65~~. 35 A method as claimed in claim 64, in which said airborne acoustic transmission is a spread spectrum acoustic signal.

~~66~~. 36 A method as claimed in claim 65, in which said airborne acoustic transmission is a pulse, frequency sweep, or digitally encoded sweep acoustic signal.

~~67.~~ 27 A method as claimed in claim 66, in which said airborne acoustic transmission is generated by signal generation circuitry that is also used to test said seismic sensor.

~~68.~~ 28 A method as claimed in claim 67, further including the step of measuring the temperature of the air near said seismic sensor or said positioning device.

~~69.~~ 29 A method as claimed in claim 68, in which said positioning device is placed near a survey flag.

~~70.~~ 30 A method as claimed in claim 69, in which said positioning device is a first positioning device and further including the step of determining the distance between a second positioning device and said seismic sensor using an airborne acoustic transmission between said second positioning device and said seismic sensor.

~~71.~~ 31 A method as claimed in claim 70, further including the step of determining the distance between said first positioning device and said second positioning device.

~~72.~~ 32 A method as claimed in claim 71, in which said step of determining the distance between said first positioning device and said second positioning device uses an airborne acoustic transmission between said first positioning device and said second positioning device.

~~73.~~ 33 A method as claimed in claim 72, in which said first positioning device and said second positioning device are connected by a cable.

74. 34 A method as claimed in claim 73, in which said second positioning device is placed at a predetermined azimuthal orientation with respect to said first positioning device.

75. 35 A method as claimed in claim 74, further including the step of confirming that said second positioning device has been placed at a predetermined azimuthal orientation with respect to said first positioning device.

76. 36 A method as claimed in claim 75, in which a seismic source signal is used to determine to resolve the line symmetry ambiguity when determining the position of said seismic sensor with respect to said first positioning device and said second positioning device.

77. 37 A method as claimed in claim 75, wherein said seismic sensor is a first seismic sensor and further including additional seismic sensors and the step of determining the distance between said additional seismic sensors and said positioning device using airborne acoustic transmissions between said positioning device and said additional seismic sensors.

78. 38 A method as claimed in claim 77, further including the step of calculating a group center of gravity for said first seismic sensor and said additional seismic sensors.

79. 39 A method as claimed in claim 77, further including the step of determining whether said first seismic sensor and said additional seismic sensors have been laid out in a prescribed order.

~~80.~~ 40 A method as claimed in claim 79, in which said seismic sensor and said positioning device are located at a first seismic station and farther including an additional positioning device located at a second seismic station and the step of determining the distance between a device located at said first seismic station and a device located at said second seismic station.

~~81.~~ 41 A method as claimed in claim 80, further including the steps of recording seismic data acquired by said seismic sensor and assigning sensor position coordinates to said seismic data based on said distance between said seismic sensor and said positioning device.

~~82.~~ 42 A method as claimed in claim 81, Further ~~farther~~ including the step of calculating a deviation between actual seismic sensor position coordinates and planned seismic sensor position coordinates.

~~83.~~ 43 A method as claimed in claim 82, further including the step of compensating for said deviation between said actual seismic sensor position coordinates and said planned seismic sensor position coordinates.

~~84.~~ 44 A method as claimed in claim 83, in which said compensation step includes mathematically moving a group center of gravity from an actual position to a planned position.

~~85.~~ 45 A method as claimed in claim 84, in which said compensation step includes bypassing a digital ground roll removal process.